Evaluation of fall versus spring

DORMANT PLANTING OF HARDWOOD WILLOW CUTTINGS

with and without soaking treatment

| Derek J Tilley and J Chris Hoag

ABSTRACT

Coyote willow (*Salix exigua* Nutt. [Salicaceae]) cuttings harvested in a dormant state during the fall and soaked in cold water for 14 d prior to planting had significantly greater root production after 70 d than did spring-harvested cuttings soaked for 14 d or non-soaked cuttings harvested in fall or spring. Similarly, dormant peachleaf willow (*S. amygdaloides* Andersson [Salicaceae]) harvested and planted in the fall after soaking for 14 d had significantly greater root production after 42 d than did cuttings harvested in the spring and not soaked prior to planting. Survival rates were similar for all treatments. Soaking and planting dormant hardwood cuttings in the fall may cause cuttings to be in a better pre-rooting condition, which can translate to better root vigor the following spring.

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KEY WORDS
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NOMENCLATURE
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All photos by Derek J Tilley

The majority of riparian restoration and streambank bioengineering projects are installed in the spring as soon as weather permits working on the ground. There are a number of reasons why spring plantings are more prevalent than fall plantings: 1) fear that fall-collected cuttings may have been stressed due to hot summer temperatures, reduced water availability, or insects and disease prior to cutting; 2) a perception that a cutting left on the tree over winter should be healthier than a cutting taken off the tree and left in the frozen ground for 6 mo; 3) the possibility that the cutting might rot during the wet dormant period; and 4) most of the project planning usually takes place during the "down time" over the winter months, and restorationists are eager in the spring to get back outside as soon as possible.

Dormant fall planting of hardwood willow cuttings can, however, be a very successful technique. To improve survival, the cuttings must be planted with the bottom of the cuttings in the lowest water table of the year, and fall is the best time to plant because the water table is often at its lowest or very near to it. Fall also presents a very long window of opportunity rather than the short planting window in the spring. After fall planting, cuttings are then ready to start growing before the weeds get going in the spring. This is very important since in most spring seasons, the ground is still too wet to get on to with equipment to plant the cuttings, which means the weeds get a head start on growth.

So, which is better, fall-planted cuttings or spring-planted cuttings? Each season has its positives and negatives. Fall planting often means that the cuttings are on the streambank much earlier than spring-planted cuttings, so some protection to bank stability is possible when the spring runoff occurs. One factor that may improve the success of fall plantings is the soaking of willow cuttings prior to being planted. Traditionally, soaking is not recommended in the fall, since the cuttings will be sitting in the ground all winter, and the cuttings should theoretically be able to absorb enough moisture to become fully hydrated by spring.

The benefits of soaking willow and cottonwood cuttings prior to planting have been well documented (Edwards and Kissock 1975; Krinard and Randall 1979; Pezeshki and others 2005; Tilley and Hoag 2007). Soaking dormant hardwood cuttings has been shown to improve survival, increase vigor, and cause greater production of roots and shoots; however, all these studies to date have examined soaking followed by immediate planting in a laboratory setting, or in field conditions in the spring where plants can immediately begin growing after planting. A literature review yielded no reports of tests evaluating the efficacy of soaking followed by a fall-dormant planting.

In this experiment 4 treatments were evaluated to determine if soaking cuttings in the fall provided any establishment benefits over traditional planting methods. Cuttings planted in the fall following a 14-d soaking treatment (F14) were compared with fall plantings with no soaking (F0), spring plantings following a 14-d soak (S14), and a non-soaked spring planting (S0).

MATERIALS AND METHODS

Cuttings of peachleaf willow (*Salix amygdaloides* Andersson [Salicaceae]) and coyote willow (*S. exigua* Nutt. [Salicaceae]) were harvested from the Aberdeen, Idaho, Plant Materials Center (PMC) willow-cutting nursery while dormant on 19 November 2007 and were stored at 4 °C (39 °F) until treatment. The cutting nursery is nonirrigated, so the cuttings were not necessarily well hydrated, but under natural stress. All cuttings were trimmed to 50 cm (20 in) in length; peachleaf willow cuttings had a basal diameter of 1.5 to 2 cm (0.6 to 0.8 in) and coyote willow cuttings had a basal diameter of 8 to 12 mm (0.3 to 0.5 in). All side branches and terminal tips were removed at the time of harvest. See Table 1 for a breakdown of harvest, soaking, planting, and evaluation dates.

The cuttings used in the fall soaking treatment were placed vertically in 19-l (5-gal) buckets filled 40 cm (16 in) deep with water (Figure 1). The buckets were then placed in cold-dark storage at 4 °C (39 °F) for 14 d prior to planting (26 November to 10 December). Plants not soaked were kept in cold-dark storage at 4 °C (39 °F) until planting. The soaked and non-soaked fall-harvested cuttings were then planted on 10 December 2007 into 0.65-l (40-in^3) conetainers filled with a 10:1 perlite/vermiculite mix. All conetainers were then placed outside and left to undergo natural conditions (Figure 2). Daily average temperatures were at or below freezing until mid-March (Figure 3). The cuttings received no irrigation other than natural rain and snowmelt. For the time the cuttings were exposed to natural winter conditions (10 December 2007 to 7 April 2008), Aberdeen received 4.9 cm (1.92 in) precipitation, mostly in the form of snow.

Cuttings for the spring treatments were harvested dormant on 10 March 2008 for peachleaf willow and 21 March for the coyote willow and put into cold storage. On 24 March, the cuttings for the spring-soak treatment were placed in 19-l (5-gal) buckets to soak. Non-soaked spring-harvested cuttings remained in cold-dark storage. On 7 April we removed the cuttings being soaked and planted all of the spring-collected cuttings (soaked and non-soaked) into 0.65-l (40-in^3) conetainers filled with the perlite/vermiculite mix.

After planting, all of the conetainers (spring and fall) were placed in an outdoor 1.2 x 2.4 x 0.6 m (4 x 8 x 1 ft) tank, so they could be watered equally through sub-surface irrigation (Figure 4). We initially filled the tank on 7

April so that water rose 8 cm (3 in) up the cones. Water levels were then manipulated to rise and fall ensuring that adequate moisture was provided for sprouting and growth.

The experiment was designed as a complete block. Each treatment consisted of 5 replications of 5 cuttings (25 cuttings per treatment).

On 19 May (42 d after planting in the spring), the peachleaf willow cuttings were carefully removed from their cones and soil was washed away. Roots and new shoots were removed and separated and air-dried for 4 d until all moisture had been removed. Roots and shoots of plants within replications were combined and weighed. Live cuttings were totaled within each replication and divided by 5 for a survival percentage.

The coyote willow cuttings were left to grow considerably longer than the peachleaf willow due to differences in growth rates. In order to have sufficient vegetation to accurately weigh, coyote willow cuttings were harvested on 16 June (70 d after spring planting) and weighed on 24 June. Data were analyzed using an analysis of variance (ANOVA) followed by a Tukey's test to separate means if significance was detected at $P = 0.05$.

RESULTS

Early in the establishment period we noted signs of stress in the F14 group. Between planting and bud break, we observed fungal infection in all cuttings that had been soaked for the 14 d prior to fall planting. Multiple black spots were visible on the bare tips of each cutting. The F14 cuttings were also later in breaking bud dormancy than the cuttings in the other treatments and were believed to be dead early in the trial. It is unknown if the infection was the reason for the mortality of 2 coyote willow cuttings in the F14 treatment. Nonetheless, the F14 treatment performed equally to or better than all other treatments in root production indicating the potential for increased short-term drought tolerance and earlier streambank stabilization benefits.

All cuttings in the peachleaf willow portion of the trial survived to harvest. Soaking in the fall for 14 d resulted in the highest production of roots and shoots (Figures 5 and 6); however, significant differences were not detected between treatments for root production ($P = 0.06$). Both fall treatments and the 14-d spring soak had significantly greater shoot production than did the spring non-soaked treatment ($P = 0.00$). Shoot biomass for the fall 14-d soaking treatment was highest at 9.05 g (0.32 oz). The fall non-soaked and spring 14-d soaking treatments had similar weights of 7.35 and 7.51 g (0.26 and 0.27 oz), respectively; while the spring non-soaked treatment had considerably lower shoot production with 4.32 g (0.15 oz).

In the coyote willow trial, the F14 treatment had slightly lower (though not significant) survival percentage than the other 3 treatments. The F0, S14, and S0 all had 100% survival

Figure 1. Dormant willow cuttings soaking (*left*) and stored without soaking (*right*) prior to fall planting.

Figure 2. Cuttings planted into conetainers in the fall and left outside over winter.

while the F14 treatment had an average of 92% survival. The F14 treatment had significantly greater root production than the other 3 treatments (Figure 7) (P = 0.00). F14 root production weighed 5.13 g (0.18 oz), more than twice the root production of the next closest treatment, S14 with 2.46 g (0.09 oz). F0 followed with 2.32 g (0.08 oz), and S0 again had the lowest production with 1.77 g (0.06 oz) of roots. Differences in shoot production between the 4 treatments were not statistically significant (P = 0.96). Highest shoot production came from the S14 treatment with 3.84 g (0.14 oz). F14 had 3.81 g (0.13 oz) and F0 and S0 weighed 3.55 and 3.77 g, respectively (both 0.13 oz) (Figure 8).

DISCUSSION

Spring plantings are more prevalent than fall plantings because many users believe there are higher establishment success rates if the cuttings are planted in the spring. Because of the possibility of having a dry fall with little cold weather, which would delay willow dormancy, planters worry that it could affect planting survival. Another concern is that around Halloween in many areas, the weather often turns quickly to winter with plummeting soil temperatures and poor planting conditions. Rather than placing a live cutting out in those conditions, planters tend to feel it is better left on the stump, cut in very early spring, and immediately planted or stored and planted as soon as possible in the spring. There is also a belief that fall-collected cuttings are under stress due to various situations that have occurred during the summer, for example, hot temperatures, too much water, too little water, insects and diseases, fires, and other such events.

Despite the predominance of spring planting, there may be good reasons to consider fall planting. Even though fall-planted cuttings are not expected to sprout until the following growing season, they can provide limited protection to a streambank just from the stems alone. Planting the cuttings in the fall should be considered because it is easier to identify the lowest water table of the year at that time than it is during the spring when water is everywhere. Additionally, soaking cuttings

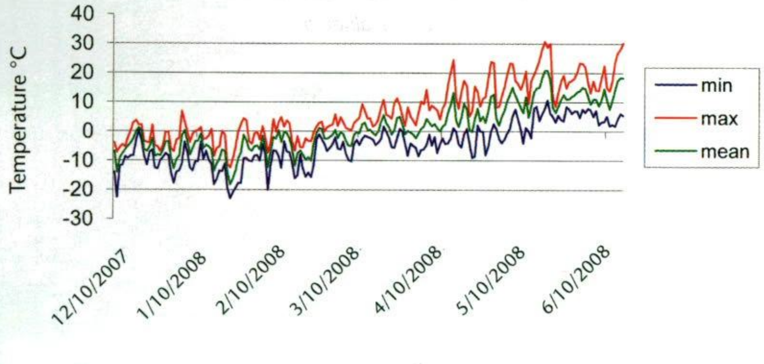

Figure 3. Daily maximum, mean, and minimum temperatures at Aberdeen, Idaho, between 10 December 2007 and 16 June 2008.

Figure 4. Cuttings in 1.2 x 2.4 x 0.6 m metal tank for irrigation and establishment.

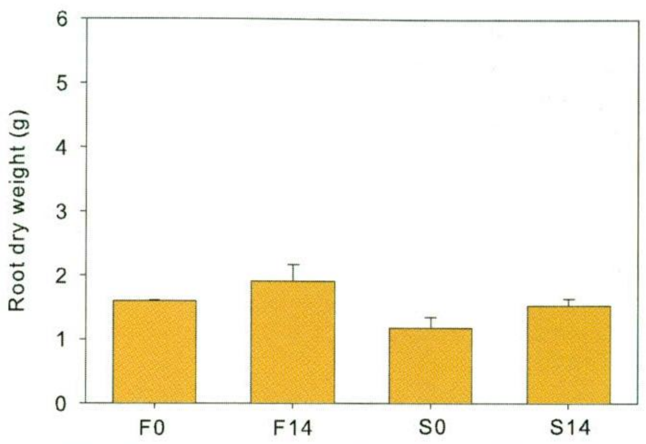

Figure 5. Dry weight biomass (grams) of roots of peachleaf willow planted as dormant cuttings after: fall planting with no soaking treatment (F0), fall planting with a 14-d soaking treatment (F14), spring planting with no soaking treatment (S0), or spring planting with a 14-d soaking treatment (S14). Error bars are +/- 1 standard error.

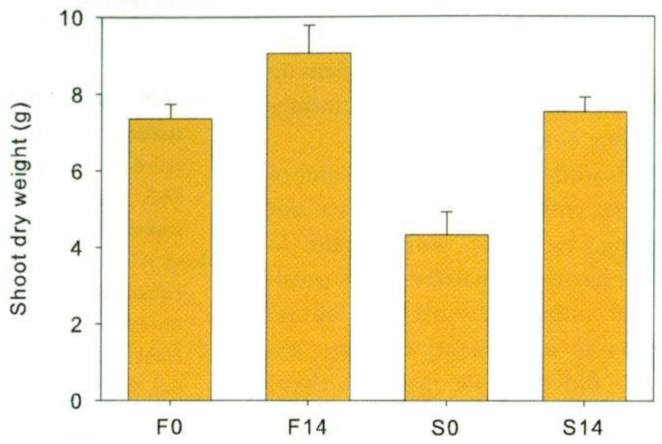

Figure 6. Dry weight biomass (grams) of shoots of peachleaf willow planted as dormant cuttings after: fall planting with no soaking treatment (F0), fall planting with a 14-d soaking treatment (F14), spring planting with no soaking treatment (S0), or spring planting with a 14-d soaking treatment (S14). Error bars are +/- 1 standard error.

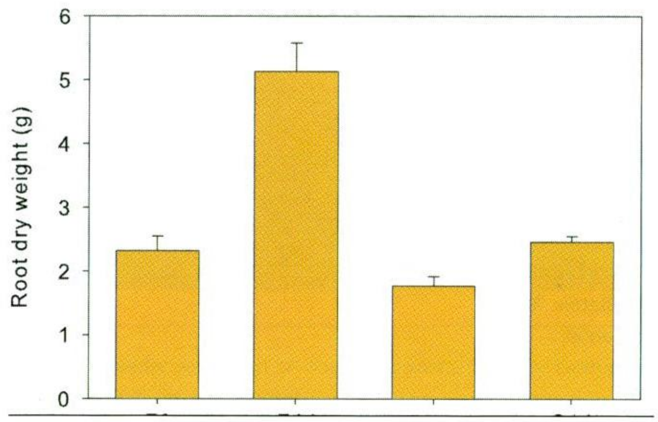

Figure 7. Dry weight biomass (grams) of roots of coyote willow planted as dormant cuttings after: fall planting with no soaking treatment (F0), fall planting with a 14-d soaking treatment (F14), spring planting with no soaking treatment (S0), or spring planting with a 14-d soaking treatment (S14). Error bars are +/- 1 standard error.

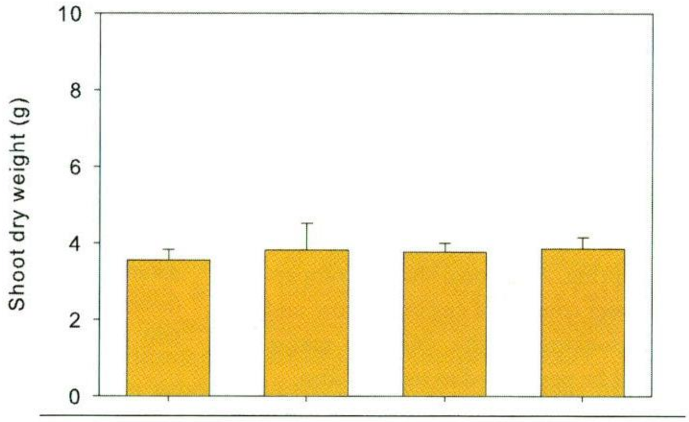

Figure 8. Dry weight biomass (grams) of shoots of coyote willow planted as dormant cuttings after: fall planting with no soakiang treatment (F0), fall planting with a 14-d soaking treatment (F14), spring planting with no soaking treatment (S0), or spring planting with a 14-d soaking treatment (S14). Error bars are +/- 1 standard error.

TABLE 1

Dates, by treatment, that peachleaf and coyote willow cttings were harvested, soaked, planted, and evaluated.

	Fall		Spring	
	Non-soaked F0	**14-d soak F14**	**Non-soaked S0**	**14-d soak S14**
Collected				
Peachleaf willow	19 Nov 07		10 Mar 08	
Coyote willow	19 Nov 07		21 Mar 08	
Soaked (both species)	NA	26 Nov to 10 Dec 07	NA	24 Mar to 7 Apr 08
Planted and moved outside (both species)	10 Dec 07		7 Apr 08	
Irrigation started (both species)	7 Apr 08			
Biomass harvest				
Peachleaf willow	19 May 08			
Coyote willow	16 Jun 08			

planted in the fall may increase the vigor of the cuttings and give them an advantage in the spring over cuttings that were not soaked in the fall.

This study demonstrates the value of soaking willow cuttings versus not soaking, especially with regard to spring-harvested materials. It is possible that cuttings harvested in the fall and planted in a dormant state lose less water (and therefore maintain vigor) over the course of the winter than do cuttings left on the tree until spring. Soaking the cuttings in the spring then restores the cutting's water content to its pre-winter levels, providing similar results to those found with non-soaked fall-harvested cuttings. Cuttings harvested and soaked in the fall may retain the increased moisture levels obtained from soaking and respond with greater root and shoot production the following spring. Soaking in the fall may also cause cuttings to be in better pre-rooting condition, resulting in better root vigor the next spring. Additional studies comparing water content of cuttings before and after soaking in the fall and spring should be performed to test this idea.

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